

Closing the Assessment Loop

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One of the purposes of having an outcomes assessment plan is continuous program improvement. An outcomes assessment plan has goals, measures, and feedback. Continuous program improvement can only be accomplished if the results obtained from the measures of achievement of the goals affect the education program. This is analogous to feedback control in which a measurement is compared to the set point (goals) and an adjustment is made upstream (within the program) to bring the measured property closer to the set point.

The act of closing the assessment loop or providing feedback to the program will probably be the most difficult aspect for engineering programs as they implement assessment plans to satisfy ABET Criteria 2000. Much of the assessment literature suggests that developing and agreeing upon goals is the most difficult aspect for faculty unaccustomed to discussing undergraduate education issues in great detail. However, the eleven goals in ABET Criteria 2000, Criterion 3, provide a “default” position for faculty unable to or who choose not to define their own set of goals.¹ There is also an extensive literature on outcomes assessment measures used at a variety of schools.²⁻⁶ Closing the assessment loop will require a paradigm shift in faculty attitudes and behavior. Faculty must be receptive to results from outcomes measures that may suggest students have not achieved the desired outcomes. They must be willing to alter the curriculum and/or their teaching methods to ensure that students do achieve the desired outcomes.

In this paper, the experiences at West Virginia University, mostly within the Department of Chemical Engineering, are used as examples of how results of outcomes measures have been used for continuous program improvement.

Results from Design Projects

In the assessment plan in Chemical Engineering at West Virginia University, the primary assessment measure is a series of individual, senior design projects which students must defend in front of at least two faculty.⁵ The defense is a feedback mechanism for students. They learn immediately what they did well and what they could have done better. It is tantamount to a one-hour, individual tutorial by two faculty. Students routinely cite this as their most significant learning experience. After each project, the faculty involved prepare an assessment report. This report is used in two ways. First of all, it is the basis for the project review provided to the class, often over several class meetings. Aspects of the project that were done well are reinforced, and aspects that require improvement are emphasized, often through additional problem assignments.

This is an example of feedback directly to students. Flexibility is required since it is not known *a priori* how much time will be needed for the project review and what the content of the review will be.

The assessment report is also circulated to all faculty. One feature contained within the report is a discussion of misconceptions or misunderstandings of basic principles manifested by a significant number of students. Aspects that were done well are also highlighted. The report is discussed at a faculty meeting if it is deemed necessary. In what may be a surprising result to many, our faculty do read and respond to the report, which provides a feedback mechanism to the remainder of the curriculum preceding the design class. One reason why this system works for us is that there has been a culture in our department, which predated formal outcomes assessment by more than a decade, supporting the discussion among faculty regarding what students should know and what they should be able to do prior to being granted a degree. This type of culture is necessary to close the assessment loop, and it will be developed gradually, if at all.

Here are a few specific examples of the feedback obtained from the design projects and presentations. When confronted with an open-ended assignment, we have observed that students often believe that there is one “correct” solution, as there is for most end-of-chapter problems. Therefore, when they get what they believe to be a reasonable solution, they stop looking for alternatives. For the past few years, the first module in the senior design class has been to use projects from previous years both to teach and to demonstrate key concepts and as creativity exercises to illustrate the existence of alternative solutions. Has this worked? To an extent it has, because we are generally getting solutions based on consideration of more alternatives, though not always as many as we might like.

There are always concepts that students seem to have difficulty learning. Many years ago, we observed that the concept of vapor pressure fell into this category. Students did not understand that the boiling point changes with pressure, and perhaps because of the complex functional form for the vapor pressure-temperature relationship, did not understand that they change in the same direction. We have made a conscious effort to reinforce this concept throughout the curriculum. It is taught and reinforced in at least four chemical engineering classes (and in at least two chemistry classes that we know of). The result is that students do seem to understand the concept. This is demonstrated in the senior projects where most students are able to use the vapor pressure concept in solving the design problem and then answer questions about the concept in the oral presentation.

Results from Interviews and Questionnaires

A part of our assessment plan is for the Department Chair to interview each class (as a whole) at the end of each academic year. The session begins with the group completing a questionnaire followed by the interview. We also have our Industrial Visiting Committee and our Academy of Distinguished Alumni interview random groups of students and report back to the faculty on the results of the interview. Questionnaires sent to alumni and their employers are also used.

Included in the information the Department Chair seeks in his interviews with students is feedback on faculty teaching. He then discusses the feedback with those faculty whom he believes would benefit most from hearing the students comments. Do faculty like this? Not all do, though the main objection is when the Department Chair cites this information in annual reviews; informal feedback seems to be better received.

All of our sophomores and juniors do a project each semester based on material in all of the classes they are taking in that semester. At one time, these projects were due and oral presentations scheduled during the last week of the semester. After receiving feedback from students that they would prefer to have the last week of the semester to catch up and prepare for finals, even though they would have one less week to work on the project, most of these projects are now due the next to last week of the semester (with no reduction in content). In the senior year, students can have as many as 10 oral presentations. In the large, year-long group design, 100+ page reports at the end of each semester are not uncommon. Students complained about the expense of transparencies for all of these presentations and about the expense of submitting multiple copies of the large reports, especially given that a special fee had been instituted for engineering students. We now do all copying for the group projects, and we provide a sufficient number of transparencies for all student presentations. These two situations are also examples of continuous program improvement. One of the principles of TQM is to include the customer and personnel at all levels in the decision making process. When these minor changes, suggested by students, were implemented, students were pleased that the Department was responding to their concerns, and they had one less distraction from achieving the goals set forth by the Department.

Another result from questionnaires and interviews had to do with the common freshman program in the College. Students at all levels in all departments were providing feedback that the freshman program had become ineffective. The College created their own questionnaires for students and faculty and found the same results. Students (and faculty) felt that the projects in the freshman year were far removed from engineering, and that too much emphasis was placed on programming instead of spreadsheeting. The freshman program was changed based on this feedback. Now, the courses are mostly project based, with more “engineering” problems, and with more of the computations done on spreadsheets. It is too soon to evaluate the outcomes of the revised freshman engineering program.

Classroom Assessment

Classroom assessment is a method for an instructor to obtain feedback on what student are learning more frequently, and often more informally, than by testing. It can be used by the instructor to determine the success of a lecture or class exercise. Classroom assessment methods have been documented extensively⁷, and several methods used successfully by this author have also been presented.⁸ Classroom assessment is often called formative assessment, since the feedback loop is very short term, and the specific purpose is to improve teaching and learning. The concept is that the more one knows about what students are learning or are having difficulty learning, the better students will learn and the better they will perform on a summative assessment exercise, i.e., a test.

The most widely-known classroom assessment technique is the “minute paper,” in which students take the last minute of a lecture to write down what they learned in that class, and the instructor uses this informal feedback to assess the success of that lecture period.⁷ A variation of this is the “muddiest point,” in which students write down the item they found the most confusing in a given lecture.⁷ Another variation of these, called the “attention quiz,” has been developed and tested in an engineering context.^{9,10} Here, the class ends with a short, multiple-choice quiz on material discussed in the just completed lecture. If the goal of a class period is for students to learn something instead of only being note takers, these classroom assessment techniques may allow the instructor to evaluate what was learned.

When I was a student, I learned the most from example problems shown in class. Since becoming a professor, I have used examples liberally in my classes. After a decade or so as a professor, I began to wonder whether students were really benefiting as much from seeing me do examples on the board as I thought they should, particularly examples which involved detailed calculations. As a result, I began experimenting with having students work on problems in class before I went over them. At first, I did this only for problems that required calculations or manipulations I thought students could not learn without first trying before seeing. Believing this to have been successful, I now use this method for most all example problems. While students are working on the problems, I circulate around the room so students can ask me questions, and I often look over their shoulders and correct mistakes observed. I assume the role of a coach rather than that of a lecturer. This also gives me the opportunity to identify misconceptions and typical errors and to correct them for the entire class.

Students can also benefit directly from classroom assessment exercises. During our year-long, senior design project, all students are required to make oral presentations at least once at either the end-of-semester or interim project reports. All students have made at least four oral presentations prior to this presentation, and many have made at least four more if their turn comes toward the end of the academic year. We tape the presentations and play it back for the entire group immediately following the presentation. The presentation is critiqued by faculty, peers, and by the presenter. This allows students to receive immediate feedback on their presentation in a comfortable environment. For most students, this is the first time they have the opportunity to see themselves making an oral presentation. In the future, we may also tape a presentation earlier in the curriculum to help students improve their presentation skills and to document the improvement of their presentation skills.

Conclusions

In conclusion, there are many ways to close the assessment loop. Only a few examples have been discussed here. Implementation of classroom assessment techniques can be accomplished by an individual faculty member and results in improved teaching and learning in a given course. Feedback from students can be used to improve their “life” as a student. Feedback from measures of program goals can be used to ensure that students achieve program objectives. However, this requires that faculty willingly accept this information and be flexible enough to use it to improve their instruction. This latter situation will most certainly require a paradigm shift in faculty attitudes towards teaching and assessment.

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